Claims

What is claimed is:

1. A remote sensing system for remotely determining the opacity of a vehicle exhaust plume comprising:

a radiation source arranged to pass radiation through an exhaust plume of a motor vehicle;

one or more detectors arranged to receive the radiation after it passes through the exhaust plume of the motor vehicle and generate at least one signal indicative of the intensity of radiation in at least two different detection bands received at the one or more detectors;

a first of said detection bands being selected to include a wavelength at which there is substantial absorption of radiation by a gaseous component of a vehicle exhaust plume, and a second of said detection bands being selected to include a wavelength at which there is substantially no absorption of radiation by a gaseous component of a vehicle exhaust plume; and

a processor programmed to determine the difference between the intensity of the radiation provided by the radiation source in the at least two different detection bands and the intensity of the radiation received by the one or more detectors in the at least two detection bands, based on the at least one signal generated by the one or more detectors, and to disregard the radiation intensity measurement in the first of said detection bands for at least one component expected to be present in the vehicle exhaust plume based at least in part on the determined intensity difference in the second detection band.

2. The system of claim 1, wherein the processor compares the intensity difference in the second detection band to intensity difference in the first detection band to determine the exhaust opacity.

3. The system of claim 2, wherein intensity measurements for one or more gaseous components of the vehicle exhaust plume are flagged as suspect when the exhaust opacity exceeds a first predetermined level and are discarded when the exhaust opacity exceeds a second predetermined level.

4. The system of claim 2 wherein percentage opacity is determined from a ratio of the intensity difference in the second detection band to the intensity difference in the first detection band.

5. The system of claim 1 wherein the second detection band includes a wavelength in the range of from about 0.3 microns to about 1.5 microns.

6. The system of claim 5 further comprising apparatus for insulating the source of radiation from ambient environmental conditions to minimize temperature changes in the radiation source.

7. A remote sensing system for remotely determining the opacity of a vehicle exhaust plume for a diesel powered vehicle comprising:

a radiation source arranged to pass radiation through an exhaust plume of a motor vehicle;

one or more detectors arranged to receive the radiation after it passes through the exhaust plume of the motor vehicle and generate at least one signal indicative of the intensity of radiation in at least two different detection bands received at the one or more detectors;

a first of said detection bands being selected to include a wavelength of radiation at which there is substantial absorption of radiation by carbon monoxide, and a second of said detection bands being selected to include a wavelength of radiation at which there is substantially no absorption of radiation by a gaseous component of a vehicle exhaust plume; and

a processor programmed to determine the difference between the intensity of the radiation provided by the radiation source in the at least two different detection bands and the intensity of the radiation received by the one or more detectors in the at least two detection bands, based on the at least one signal generated by the one or more detectors, and to disregard the radiation intensity measurement in the second of said detection bands for exhaust opacity based at least in part on the determined intensity difference in the first detection band.

8. The system of claim 7, wherein the exhaust opacity measurement is discarded based upon a variance from a predetermined correlation between the determined intensity difference in the first detection band and the determined intensity difference in the second detection band.

9. The system of claim 8, wherein the one or more detectors generate at least one signal indicative of the intensity of radiation in at least three different detection bands received at the one or more detectors;

the third detection band including a wavelength of radiation absorbed by carbon dioxide; and

wherein the processor compares the intensity difference in the third detection band to intensity difference in the second detection band to determine the exhaust opacity.

10. The system of claim 9, wherein intensity measurements for one or more gaseous components of the vehicle exhaust plume are flagged as suspect when the exhaust opacity exceeds a first predetermined level and are discarded when the exhaust opacity exceeds a second predetermined level.

11. The system of claim 9, wherein percentage opacity is determined from a ratio of the intensity difference in the third detection band to the intensity difference in the second detection band.

12. The system of claim 8, wherein the second detection band includes a wavelength in the range of from about 0.3 to about 1.5 microns.

13. The system of claim 12, further comprising apparatus for insulating the source of radiation from ambient environmental conditions to minimize temperature changes in the radiation source.

14. A method for remotely sensing exhaust emissions to determine the opacity of an exhaust plume from a motor vehicle comprising the steps of:

a) passing radiation from a radiation source through an exhaust plume of a motor vehicle;

b) receiving the radiation at one or more detectors after it passes through the exhaust plume of the motor vehicle;

c) generating at least a first signal indicative of the intensity of the radiation received at the one or more detectors in a first detection band which

includes a wavelength at which there is substantial absorption of radiation by a gaseous component of the exhaust plume, and a second signal indicative of the intensity of the radiation received at the one or more detectors in a second detection band which includes a wavelength at which there is substantially no radiation absorbed by a gaseous component of the exhaust plume;

d) determining from the first and second generated signals the difference between the intensity of the source radiation and the intensity of the radiation received at the one or more detectors in the first and second detection bands;

e) comparing the determined differences in said first and second detection bands to obtain a measurement of the exhaust opacity; and

f) discarding the radiation intensity measurements in said first detection band if the exhaust opacity exceeds a predetermined threshold level.

15. The method of claim 14 further comprising the step of:

g) repeating steps a-f until the exhaust opacity no longer exceeds the predetermined threshold level.

16. The method of claim 15 further comprising the step of:

h) determining the concentration of at least one gaseous component of the vehicle exhaust plume from the determined intensity difference in at least one of the detection bands which contains a wavelength at which there is substantial absorption of radiation by that gaseous component of the exhaust plume.

17. The method of claim 16, wherein the first detection band includes a wavelength at which there is substantial absorption of radiation by carbon dioxide.

18. The method of claim 17 for use in determining the exhaust opacity of a diesel powered vehicle, further comprising the steps of:

generating a third signal indicative of the intensity of the radiation received at the one or more detectors in a third detection band which includes a wavelength at which there is substantial absorption of radiation by carbon monoxide;

determining from the third generated signals the difference between the intensity of the source radiation and the intensity of the radiation received at the one or more detectors in the third detection band;

validating the exhaust opacity by comparing the determined intensity difference in the third detection band with a predetermined correlation between exhaust opacity and carbon monoxide concentration.

19. The method of claim 17, wherein the second detection band comprises a wavelength in the range of from about 0.3 microns to about 1.5 microns.

20. A method for remotely sensing exhaust emissions to determine the opacity of an exhaust plume from a diesel powered vehicle comprising the steps of:

a) passing radiation from a radiation source through an exhaust plume of a motor vehicle;

b) receiving the radiation at one or more detectors after it passes through the exhaust plume of the motor vehicle;

c) generating at least a first signal indicative of the intensity of the radiation received at the one or more detectors in a first detection band which includes a wavelength at which there is substantial absorption of radiation by carbon monoxide, a second signal indicative of the intensity of the radiation received at the one or more detectors in a second detection band which includes a wavelength at which there is substantially no radiation absorbed by a gaseous component of the exhaust plume; and

d) determining from the first and second generated signals the difference between the intensity of the source radiation and the intensity of the radiation received at the one or more detectors in the first and second detection bands;

e) determining exhaust opacity from said intensity difference in said second detection band;

f) discarding the determined exhaust opacity if the intensity difference in the first detection band does not fall within a predetermined correlation with the exhaust opacity.

21. The method of claim 20 wherein the second detection band comprises a wavelength in the range of from about 0.3 microns to about 1.5 microns.